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ABSTRACT

Based on a set of theoretical assumptions relating to the cognitive modificability of low functioning adolescents, a program of Instrumental Enrichment was developed and implemented with 41 hearing impaired secondary students. The primary goals of Instrumental Enrichment included: (1) improving performance in spatial relations, (2) improving performance in abstract analogies, (3) improving the ability to use more than one rule to solve a problem, (4) fostering more systematic approaches to problem solving, (5) fostering more accurate reading and following directions, and (6) increasing use of appropriate language for planning and sequencing events. The long term or secondary goals included improvement in reading and math skills. Eight instruments administered pre and post were: Raven's Progressive Matrices, Kit-Factor Referenced Cognitive Test (KFRCT--Diagramming Relationships), KFRCT--Letter Sets, Written Problem Solutions, Teacher Observation Checklist, Stanford Achievement Test--Hearing-Impaired Version (SAT-HI), Reading Comprehension, SAT-HI Math Concepts and SAT-HI Math Computation. For the Instrumental Enrichment group after 1 year there were several important and consistent trends. The performance of the Instrumental Enrichment group on the Raven's Progressive Matrices was nearly three times higher than that of a suitably matched group of control students representing a statistically significant difference. The other two psychometric tests, Diagramming Relationships and Letter Sets, showed no significant findings but the trends for the Instrumental Enrichment group were in the direction hypothesized. For the Problem-Solving Solutions as a whole, there was clear evidence that the Instrumental Enrichment group performed better than the control group. For the Teacher Observation Checklist, the Instrumental Enrichment group showed significant gains in work habits and classroom behavior. (Author/CL)

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COGNITIVE IMPROVEMENT OF HEARING-IMPAIRED HIGH SCHOOL STUDENTS THROUGH INSTRUCTION IN INSTRUMENTAL ENRICHMENT

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Abstract

An Evaluation of Performance of MSSD Students Exposed to Instrumental Enrichment for One Year as Compared to a Matched Group of Controls

Based on a set of theoretical assumptions relating to the cognitive modifiability of low functioning adolescents, a program of Instrumental Enrichment was developed (Feuerstein, 1978). The primary goals of Instrumental Enrichment include: a) improving performance in spatial relations, b) improving performance in abstract analogies, c) improving the ability to use more than one rule to solve a problem, d) fostering more systematic approaches to problem solving, e) fostering more accurate reading and following directions, f) increasing use of appropriate language for planning and sequencing events. The long term or secondary goals include improvement in reading and math skills.

An evaluation aimed at assessing this set of goals for hearing-impaired students was implemented during the 1982-83 academic year at MSSD. The research design is a pre- and post-test model on experimental (IE) and control (Non-IE) groups each comprising 41 students. Experimental and Control groups were matched on the basis of sex, age, and level of class placement (Remedial, Regular or Advanced Placement).

In order to measure and compare relative gains for all the primary and long-term goals listed, eight instruments were administered pre (October, 1982) and post (June, 1983). They are: 1) Raven's Progressive Matrices, 2) Kit-Factor Referenced Cognitive Test (KFRCT--Diagramming Relationships), 3) KFRCT--Letter Sets, 4) Written Problem Solutions, 5) Teacher Observation Checklist, 6) Stanford Achievement Test--Hearing-Impaired Version (SAT-HI), Reading Comprehension, 7) SAT-HI Math Concepts, 8) SAT-HI Math Computation. The psychometric tests listed here (1, 2, 3) all measure aspects of ability to reason abstractly and group concepts into logical and analogical forms. The written problems (4) pose life-adjustment situations to students in order to measure logical problem formulation and language sequencing. The teacher observation checklist (5) should help determine a profile of the efficacy of this approach toward providing general study skills and improving classroom behavior. The SAT-HI subtests (6, 7, 8) cover the long-term goals of improvement in reading and mathematics.

For the Instrumental Enrichment group after one year there are several important and consistent trends that can be reported. The performance of the Instrumental Enrichment group on the Raven's Progressive Matrices is nearly three times higher than that of a suitably matched group of control students representing a statistically significant difference. The other two psychometric tests, Diagramming Relationships and Letter Sets show no significant findings but the trends for the Instrumental Enrichment group were in the direction hypothesized. For the Problem-Solving Solutions as a whole, there is clear evidence that the Instrumental Enrichment group performed better than the control group. For the Teacher Observation Checklist the Instrumental Enrichment group showed significant gains in work habits and classroom behavior. The SAT-HI achievement data will be available in January 1984.

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The Problem

Teachers who work with hearing-impaired adolescents frequently express deep concern and frustration about some of their students' serious deficiencies in problem-solving skills, as evidenced in both classroom and written work. The concern often relates to difficulty with manipulating more than one variable, conceptualizing what a textbook or journal author is saying, forming conclusions, dealing with hypothetical data, and spatial reasoning. Yet research with hearing-impaired adolescents has documented that no basic malfunctions are present in the cognitive abilities of that population and that any inferiorities in cognitive performance may be accounted for by experiential and linguistic deficits and communication handicaps (Levine, 1976, 28).

Theoretical Background

Studies in cognition in relation to hearing-impaired individuals have been numerous in recent years. After an initial period of focusing on IQ, the center of attention now is on the processes involved in cognition and perception. It appears to be widely accepted that hearing-impaired individuals have the normal range of intelligence when tested on the performance, rather than the verbal, subtests of various IQ instruments (Drever & Collins, 1928), with the exception of students who have neurological impairments resulting from an etiology of hearing loss that has multiple effects (Vernon, 1968, 8).

Thus, we see normal performance by hearing-impaired individuals on some cognitive tasks and not on others, we also see controversy among the researchers, as well as a number of unanswered questions for further research.

Rationale for Intervention

If we accept the fact that certain specific cognitive deficiencies do exist for hearing-impaired individuals but that no evidence suggests less than the normal range of intellectual potential among hearing-impaired individuals as a group, then it is apparent that a specific program of activity in an educational setting may promise improvement of these skills. In addition, a program which was originally developed to improve the performance of disadvantaged-hearing individuals as a group, then it is apparent that a specific program of activity in an education setting may promise improvement of these skills. In addition, a program which was originally developed to improve the performance of disadvantaged-hearing children who had some of the same deprivation of thinking skill opportunities as the hearing-impaired children may well be specifically the type of program which is adaptable for this special purpose.

Such a program is Instrumental Enrichment (IE), developed originally in Israel by Reuven Feuerstein (1978, 1980), a student of Piaget, in response to the need for mediated learning experiences for culturally disadvantaged groups emigrating to Israel. This program provides an excellent mechanism in relation to the results to those studies cited earlier, for the following reasons:

a. It uses a "metacognition" approach in that students are given repeated opportunities to reflect on their own thinking processes.

b. Unlike cognitive training programs focusing on impulsivity as a personality characteristic, Feuerstein's work assumes that impulsivity is a characteristic of the "retarded performer" due to his lack of adequate mediated learning experience; thus, IE assumes that impulsivity may be reduced or limited, but for a different reason than the other programs.

c. IE definitely develops the prerequisites for learning and does not assume that those prerequisites already exist in the learner (an assumption made in several of the less-than-completely-successful intervention programs mentioned elsewhere in the literature).

d. IE recognizes the age-specificity of developing generalizable cognitive strategies: Feuerstein is unambiguous about the IE program's appropriateness only for learners at the representational level of thinking and beyond.

e. IE does not assume that generalization will automatically occur; rather, a critical element in the daily instructional sequence for IE is the "bridging" exercise in which the teacher overtly and actively promotes transfer by the student or skills to both real-life and curricular situations. This activity occurs during group discussion for insight and requires specific teacher training.

Thus, because of its avoidance of the pitfalls of earlier programs in the above respects, the IE program represents a highly logical intervention step in the history of cognitive intervention programs.

The foci of the four IE "instruments" used during the one-year intervention with the experimental group include: parts-wholes, comparison, projection of virtual relationships, and spatial relationships. The primary goals of Instrumental Enrichment include:

1. To correct deficient cognitive functions, such as:

   a. Improving performance in spatial relations,
   b. Improving performance in abstract analogies,
   c. Improving the ability to use more than one rule to solve a problem,
   d. Fostering more systematic approaches to problem-solving,
   e. Fostering more accurate reading and following of directions,
   f. Better use of appropriate language for planning and sequencing events.

2. To develop motivation to work on a task because of the nature of the task and its mastery.

3. To produce insight and understanding of one's own thought processes, and the underlying reasons for success and failure.

4. To create both an intrinsic need system and proper work habits so that the use of acquired operations, techniques, strategies, and processes will be spontaneous and automatic.

5. To help the slow performer change his attitude toward himself as a passive recipient and reproducer to that of an active generator of information, with the ability to infer and reach proper conclusions.

Long-term or secondary goals include improvement in reading and math skills.

Design

An evaluation aimed at assessing the level of success of IE in attaining this set of goals for hearing-impaired students was implemented during the 1982-83 academic year at the Model Secondary School for the Deaf (MSSD), in Washington, DC. All teachers of experimental subjects were required to complete an intensive 6-day training session as a condition of using the IE materials and methods. The research design was pre- and post-test modeled on experimental (IE) and control (non-IE) groups--each comprising approximately 50 students. Experimental and control groups were matched on the bases of sex, age, and level of class placement (remedial, regular, or advanced placement). The basic statistical rationale of such a design was to look at gains and performance of the IE group relative to the control group.

In order to measure and compare relative gains for all the primary and long-term goals listed, eight instruments were administered pre (October, 1982) and post (June, 1983). They were:

1. Raven's Progressive Matrices
2. Kit of Factor Referenced Cognitive Test (KFRCT--Diagramming relationships)
3. KFRCT--Letter sets
4. Written problem solutions
5. Teacher observation checklist
6. Stanford Achievement Test--Hearing-Impaired Version (SAT-HI) reading comprehension
7. SAT-HI math concepts
8. SAT-HI math computation

The psychometric tests listed here (1, 2, 3) all measure aspects of ability to reason abstractly and group concepts into logical and analogical forms. The written problems (4) pose life-adjustment situations to students in order to measure logical problem formulation and language sequencing. The teacher observation checklist (5) was designed to determine a profile of the efficacy of this approach toward providing general study skills and improving classroom behavior.

The SAT-HI subtests (6, 7, 8) cover the long-term goals of improvement in reading and mathematics. SAT-HI achievement data will be available in January 1984 and are therefore not able to be analyzed in this report.

The Study Population

During the 1982-83 academic year approximately 50 experimental IE students were enrolled in either English or mathematics instruction groups. By the end of the 1983 academic year attrition had resulted in the loss of 9 experimental subjects due to several teachers not participating in IE for the full year. A matched group of 41 controls was assessed vis-a-vis the experimental group. Groups were matched on the basis of age, sex, and class placement. The average age for IE group members was 16.4 years old and the average age for control subjects was 16.7 years old. In each group there were 27 females and 14 males. Also, in each group there were 18 subjects in remedial level classes, 9 subjects in regular placement classes and 14 subjects in advanced placement classes. These three levels broadly defined the academic functioning level of the students, with the remedial group constituting the lowest functioning students and the advanced placement group representing the highest functioning students. Other factors broadly controlled for, while not matched group-by-group, included the particular Instrumental Enrichment class group, ethnic background, and whether or not a student was freshman, middle, or senior year. For the IE population, 31 students were enrolled in an English IE instructional group while the remaining 10 students were enrolled in a special math IE instructional group. Of the entire population, 52 of the students were white and 30 were black. Of these, the IE group had 27 white and 14 black students, and the control group had 26 white and 15 black students. Also for the entire population, 26 were new incoming students, 34 were

second or third-year (middle) students and 22 were seniors or fourth-year students. Of these, the IE group had 18 new incoming students, 16 middle students and 7 seniors. The control group had 9 new students, 18 middle students and 14 seniors. Thus, the two study populations were well balanced on these educational and demographic factors.

Psychometric Tests

All evaluation instruments followed a pre- and post-administration on controls and experimental groups with the exception of the teacher observation checklist. This particular inventory involved assessments from other teachers of the IE students only. This teacher observation checklist gave another teacher of an IE student the opportunity for chance to assess pre and post whether he or she has detected any difference in the student's ability in terms of his classroom behavior or his work or study skill habits; hence for this particular measure, the focus was on the IE students solely. The use of statistical significance testing was not deemed appropriate for individual items on this measure. Instead, the pre and post item ratings are provided in a descriptive manner. In addition, however, the items were grou[illegible] into WORK HABITS (items 1-10) and CLASSROOM BEHAVIOR (items 11-20) subscales. These subscales have been evaluated statistically using a paired t-test.

Results

Raven's Matrices

Table 1 presents the mean pre- and post-test scores for the experimental and control groups on the Raven Matrices. In addition, Table 1 presents the mean gain from pre- to post-test administration and the results of an analysis of covariance showing the effect of group affiliation by using an F-statistic and its associated

Table 1

Comparison of Experimental and Control Groups on Raven's Matrices

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	41.9	44.8	2.9	5.36	$p < .02$
Control (Non-I.E.) (N=41)	41.8	42.8	1.0		

probability. The pre-test means are 41.8 for the control group and 41.9 for the experimental group. The post-test means are 42.8 for the control group and 44.8 for the experimental group. Hence, the gains are 1.0 points on the average for the control group and 2.9 points on the average for experimental group. The experimental group shows almost a three-fold increase in gain over the control group. After the effect of the pre-test has been accounted for, there was still a significant F (F=5.36). The associated probability was less than .02; hence, there is a statistically significant relationship found between the experimental Instrumental Enrichment approach in gains on the Raven's Matrices. The extent of the incremental gain of the experimental group supports the notion that as measured by the Raven's Progressive Matrices, the Instrumental Enrichment intervention proves to be a superior teaching method. Also, it is worth noting that the pre- and post-test scores are out of a possible maximum of 60 items correctly completed on Raven's Progressive Matrices; hence, scores of 41 to 45 represent approximately 66 percent to 75 percent of the items correctly completed. Because the Raven's Matrices is a well-validated test that measures logical and analogical skills and because the scoring range for both experimental and control groups is above 50 percent indicating that students were able to correctly attempt the

majority of the test items, it is accepted that this is an appropriate measure of the outcome of Instrumental Enrichment and that it documents that Instrumental Enrichment is a superior teaching method for cognitive improvement.

Diagramming Relationships

Diagramming Relationships is a test that consists of portraying the relationship between three English nouns such as furniture, desk, and chairs to a Venn diagram relationship such as one large circle and two small circles within it.

Table 2 presents the mean scores, mean gain, F-statistic, and associated probability for the Diagramming Relationships test. The experimental and control pre-test mean are 8.5 and 9.4, respectively. The post-test means are 9.6 and 10.2, respectively. The experimental group therefore gained 1.1 points on the average and the control group gained 0.8 points. The associated test of significance between the two gains show nonsignificance due to the fact that both groups gained approximately the same amount on this particular psychometric test.

Table 2

Comparison of Experimental and Control Groups on Diagramming Relationships

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	8.5	9.6	1.1	0.8	N.S.
Control (Non-I.E.) (N=41)	9.4	10.2	0.8		

Letter Sets

The Letter Sets test represents a series of 4-alphabet characters with one of five similar choices from which the student must pick the choice that is analogically closest. An example would be a string A-B-C-D and of the five choices

presented, the student may pick the only one that also represents alphabetical order such as D-E-F-G.

Table 3 shows the mean, pre- and post-test scores, and gains for the experimental and control groups on the Letter Sets test. The experimental pre-test mean is 13.2, and the control groups mean is 14.2. The experimental post-test mean is 15.3 and the control post-test mean is 15.6; hence, the experimental group gains on the average 2.1 points while the control group gains 1.4 points. The associated F-statistic is 1.3 which represents nonsignificant difference the two gains. Like the Diagramming Relationships test, the Letter Sets test also has a maximum score of 30 correct items. While the means both pre and post for both groups are higher than the Diagramming Relationships test, approaching the 50 percent mark, there is no significant difference between groups and the percentage of correct responses is not high enough to indicate that either group on either test administration came close to mastering the intent of this test. While the experimental group does show a somewhat higher trend than the control group upon the gains on the Letter Sets test, is judged to be somewhat too difficult for first-year Instrumental Enrichment students.

Table 3

Comparison of Experimental and Control Groups on Letter Sets

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	13.2	15.3	2.1	1.3	N.S.
Control (Non-I.E.) (N=41)	14.2	15.6	1.4		

Problem-Solving Solutions

Problem-solving homework solutions were given to students at both pre- and post-test administration time to complete as homework assignments. Each experimental control subject was given the assignment of answering 3 life-situation questions. The three questions were:

1. Suppose you are responsible for planning a trip for a class to go from MSSD to downtown Washington for a whole day to visit the Capitol Building. What steps would you take? Please list the things you would have to plan.

2. If you had to tell someone exactly how to walk from the auditorium at MSSD to the cafeteria, what directions would you give him or her?

3. You are in a restaurant downtown with an MSSD friend. After dinner, your friend becomes sick from the food he has eaten. He cannot walk, and he is in pain. The restaurant manager cannot help you. What would you do?

Written answers to the Problem-Solving Solutions were obtained from the students both in the experimental Instrumental Enrichment group and the control group. The tests were rated by two raters, both pre and post, on several different factors:

1. A global rating.

2. Practicality of the solution.

3. Completeness of the solution: How complete the solution is, based on the given information.

4. Organization of the solution: How well the information is presented in a natural or logical sequence.

5. Systematic rating: How well the individual has planned his solution in a premeditated manner.

Ratings were based on a 1 to 5 scale where 1 represented very low, 2 represented somewhat low, 3 represented medium, 4 represented somewhat high, and 5 represented a very high rating. The two raters' scores were correlated over each of the five rating categories for the three problems administered pre and post. Hence, there were 30 correlations between the two raters. The average correlation

of the 0.82 represents the best estimate of inter-rater reliability. Table 4 represents the global rating for Problem 1. The two gains are 0.4 for the experimental and 0.3 points for the control group; hence, there is a nonsignificant

Table 4

Comparison of Experimental and Control Groups on Problem 1: Global Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.2	2.6	0.4	0.8	N.S.
Control (Non-I.E.) (N=41)	3.1	3.4	0.3		

effect of experimental, Instrumental Enrichment instruction on the global rating for Problem 1.

Table 5 presents the global rating for Problem 2. Here the experimental group gains 1.1 points while the average control group gains 0.4 points representing an F of 2.6 which while somewhat approaching significance, is still in the nonsignificant range. Hence, as an overall rating, Problem 2 does not show any significant trends between experimental and control groups.

Table 5

Comparison of Experimental and Control Groups on Problem 2: Global Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.4	3.5	1.1	2.6	N.S.
Control (Non-I.E.) (N=41)	3.1	3.5	0.4		

Table 6 presents the global rating for Problem 3. Here the experimental group gained 0.9 points while the control group loses an average 0.4 points, representing an F of 10.4 which is highly significant. Hence, for Problem 3 (instructions a deaf person would give to a restaurant manager when having a sick

Table 6

Comparison of Experimental and Control Groups on Problem 3: Global Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.3	3.2	0.9	10.4	$p < .01$
Control (Non-I.E.) (N=41)	2.8	2.4	-0.4		

friend with him or her), shows that the experimental Instrumental Enrichment group did significantly better from pre- to post-test on how they would approach this problem.

Tables 7 through 9 present the 3 problem-solving solutions with the practicality rating. Here the trends are similar to that seen for the overall global rating. Problem 1 shows a nonsignificance between the two groups and additionally shows that neither group gained significantly on their rating from pre- to post-test. Problem 2 shows a trend in the direction for the Instrumental Enrichment group which is nonsignificant. Problem 3 shows a significant trend for the Instrumental Enrichment group for the practicality rating where the Instrumental Enrichment group gains on the average of nearly a full point in their rating and the control group stays approximately the same from pre- to post-test on their rating. Again, in the area of the practicality of the solution, it seems clear that on Problem 3 the Instrumental Enrichment group did significantly better.

Table 7

Comparison of Experimental and Control Groups on Problem 1: Practicality Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.1	2.2	0.1	0.1	N.S.
Control (Non-I.E.) (N=41)	3.2	3.4	0.2		

Table 8

Comparison of Experimental and Control Groups on Problem 2: Practicality Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.2	2.7	0.5	0.4	N.S.
Control (Non-I.E.) (N=41)	2.9	3.1	0.2		

Table 9

Comparison of Experimental and Control Groups on Problem 3: Practicality Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.5	3.4	0.9	4.6	$p < .05$
Control (Non-I.E.) (N=41)	2.7	2.6	-0.1		

Tables 10 through 12 represent the three completeness ratings. Here again, trends are somewhat similar to those presented above. The difference on Problem 1

is nonsignificant. Problem 2 shows a trend in favor of the Instrumental Enrichment group, in which that group gained a full point in rating as compared to the control groups' gain of 0.7 points. However, this trend is nonsignificant. Table 12 presents the Problem 3 completeness rating, and there is a trend which is significantly in favor of the Instrumental Enrichment group.

Table 10

Comparison of Experimental and Control Groups on Problem 1: Completeness Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	1.6	1.8	0.2	0.4	N.S.
Control (Non-I.E.) (N=41)	2.6	2.6	0.0		

Table 11

Comparison of Experimental and Control Groups on Problem 2: Completeness Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	1.8	2.8	1.0	0.6	N.S.
Control (Non-I.E.) (N=41)	2.5	3.2	0.7		

Table 12

Comparison of Experimental and Control Groups on Problem 3: Completeness Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.1	2.7	0.6	5.8	$p < .05$
Control (Non-I.E.) (N=41)	2.5	2.4	-0.1		

Tables 13 through 15 represent the organization ratings for the 3 problem-solving solutions. Table 13 shows that neither group did particularly well on Problem 1 in terms of the organization rating gain since each group lost on the average 0.2 points. Hence, the results are nonsignificant. Table 14 again shows a trend in the favor of the Instrumental Enrichment group which gains 1.1 point on the average while the control group gains only 0.2 points. However, the F is still nonsignificant at the .05 probability level. Table 15 presents the organization rating for Problem 3 and does show a significant trend in the favor of the Instrumental Enrichment group which gains on the average of 1.1 point while the control group neither gains or loses ground on the average.

Table 13

Comparison of Experimental and Control Groups on Problem 1: Organization Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.4	2.2	-0.2	0.1	N.S.
Control (Non-I.E.) (N=41)	3.3	3.1	-0.2		

Table 14

Comparison of Experimental and Control Groups on Problem 2: Organization Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.3	3.4	1.1	3.6	N.S.
Control (Non-I.E.) (N=41)	3.2	3.4	0.2		

Table 15

Comparison of Experimental and Control Groups on Problem 3: Organization Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.3	3.4	1.1	5.6	$p < .05$
Control (Non-I.E.) (N=41)	2.7	2.7	0.0		

Finally, Tables 16 through 18 show the systematic ratings for the 3 problem-solving solutions. Table 16 actually shows a trend in the favor of the control group which gains on the average of 0.5 points while the experimental group loses on the average of 0.2 points representing an F of 1.9. However, this F is still nonsignificant. Table 17 presents the systematic rating for Problem 2 and shows a rating this time in the favor of the experimental group which gains on the average 1.5 points while the control group gains 0.7 points. However, the F is still nonsignificant. Finally, Table 18 presents the systematic rating for Problem 3 and as before, show a significant trend in the favor of the Instrumental Enrichment group which gained 1.0 points on the average while the control group lost 0.1 points on the average, representing an F of 4.1 which is significant below the .05 probability level.

Table 16

Comparison of Experimental and Control Groups on Problem 1: Systematic Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.0	1.8	-0.2	1.9	N.S.
Control (Non-I.E.) (N=41)	2.5	3.0	0.5		

Table 17

Comparison of Experimental and Control Groups on Problem 2: Systematic Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.0	3.5	1.5	3.1	N.S.
Control (Non-I.E.) (N=41)	3.0	3.7	0.7		

Table 18

Comparison of Experimental and Control Groups on Problem 3: Systematic Rating

Group	Mean Score 10/82	Mean Score 6/83	Mean Gain from 10/82 to 6/83	F	p
Experimental (I.E.) (N=41)	2.2	3.2	1.0	4.1	$p < .05$
Control (Non-I.E.) (N=41)	2.8	2.7	-0.1		

Teacher Observation Checklist

Table 19 presents the Teacher Observation Checklist for the Instrumental Enrichment group. Teachers of all experimental students were asked to rate students' cognitive behavior before the beginning of the experimental period and again at the end of the first year using the 5-point scale of behaviors where one is a low rating and 5 is a high rating reflecting the major goals of IE. The teachers reporting were not those involved in the IE teacher-training group; thus, they had no specific preconceived expectations for any changes in student behavior. The items displayed in Table 19 were tallied across the students in means determined for each scale item. The scaled means were then compared between pre-

Table 19

Teacher Observation Checklist: Weighted Means for Experimental Group

TYPICALLY, THIS STUDENT	Pre (1=low; 5=high)	Post (1=low; 5=high)	
* 1. Corrects own mistakes spontaneously	3.0	3.6	
2. Uses dictionary spontaneously	2.5	2.5	
* 3. Takes responsibility for own supplies	4.1	4.4	
* 4. Settles down to work rapidly at beginning of class	3.3	3.9	
* 5. Makes a minimum number of errors and erasures	3.1	3.4	
* 6. Reads and follows directions spontaneously	2.8	3.2	
* 7. Takes responsibility for making up work missed	3.2	4.0	
8. Concentrates on task at hand for appropriate period of time	3.6	3.8	
* 9. Expects himself/herself to be precise, exact	3.1	3.6	
*10. Gives relevant and complete answers to questions	2.8	3.7	
ITEMS 1 THROUGH 10 = WORK HABITS AVERAGE	3.1	3.6	t=2.87 (p=.02)
*11. Willing to help others in class	3.2	3.8	
*12. Approaches new tasks and work with confidence	2.9	3.4	
13. Participates willingly in oral discussions	3.5	3.5	
*14. Volunteers to do extra work	1.8	2.3	
15. Looks for alternative ways of doing things	1.9	2.0	
*16. Works well with others in a group	3.0	4.0	
*17. Is enthusiastic about learning	3.6	3.9	
*18. Is considerate of others' feelings and listens to others	3.5	4.2	
*19. Act without impulsivity	3.2	4.0	
*20. Avoids being involved in fights and arguments	4.0	4.7	
ITEMS 11 THROUGH 20 = CLASSROOM BEHAVIOR	3.2	3.6	t=2.63 (p=.03)

* Increase of +.3 or more

and post-surveys to determine changes in teachers' perceived behavior of the experimental students. For individual items, a more descriptive approach is taken where differences are inspected for clear trends. Changes between pre- and post-

survey items of 0.3 or more are considered noteworthy because 0.3 represents the average item's standard error of measurement in this rating scheme. In addition, items 1 through 10 represent aspects of work habits of students and items 11 through 20 represent aspects of classroom behavior. Hence, in addition, overall subtest averages for each of these 10 item pools were computed. For 10 scaled items averaged together the standard error of measurement is 0.1 points; hence, differences between pre- and post-test ratings for these subtests in excess of .3 would be highly noteworthy as they would at least doubly exceed the standard error of measurement. Also t-statistics are computed for these subscale scores. The following items exhibited a change of .3 or more: 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 16, 17, 18, 19, 20. There are two highly evident trends. They are: (1) that 8 out of the 10 items listed under Work Habits exceeded the standard error of measurement and similarly, 8 out of 10 items listed under classroom behavior exceeded the standard error of measurement; (2) the overall subtest means for work habits exceeds the standard error of measurement ($t=2.87$, probability = .02) and for classroom behavior the mean also exceeds the standard error of measurement ($t=2.63$, probability = .03). Thus, there is strong evidence to suggest that the perceived increases in work habits and classroom behavior for the Instrumental Enrichment students are highly noteworthy.

Summary

For the Instrumental Enrichment group after one year there are several important and consistent trends that can be reported.

1. The performance of the Instrumental Enrichment group on the Raven's Progressive Matrices which is considered to be one of the best measures of logical and deductive reasoning, is nearly three times higher than that of a suitably matched group of control students. Hence, after one year, there are demonstrated differences in the Instrumental Enrichment group's ability to perceive logical and deductive patterns.

2. While the other two psychometric test--namely Diagramming Relationships and Letter Sets--that were used to evaluate aspects of performance and logical reasoning appeared to show no significant findings, the trends for the Instrumental Enrichment group were in the hypothesized direction.

3. For the Problem-Solving Solutions as a whole, there is clear evidence that the Instrumental Enrichment group performed better than the control group; therefore, performance was significantly better on Problem 3 and the performance tended in the hypothesized direction on Problem 2.

4. In terms of the teachers' ratings of student behaviors and study habits for the Instrumental Enrichment group alone, 16 out of the 20 ratings were in excess of the standard error of measurement; hence, there is highly supportive evidence that the Instrumental Enrichment group showed gains in their ability to conduct their activities in class in a business-like manner and proceed with problem-solving in a more systematic manner and formulate more systematic rules to solve a problem and were better at following directions. Also, both subscale scores, WORK HABITS and CLASSROOM BEHAVIOR reflect significant improvement in one academic year.

Conclusions

From this systematic cognitive intervention, one may therefore draw the following conclusions:

1. Adolescence is apparently not too late to begin a systematic program of cognitive improvement for the hearing-impaired learner.

2. Teacher-training is an essential prerequisite for a curricular intervention involving content-free cognitive materials which are integrated into the regular subject matter.

3. Dissemination of these results to other programs for the hearing-impaired is now appropriate.

4. A larger student sample and a resulting more complex evaluation design are now appropriate for investigation and replication of these apparent effects.

Other investigators and interested educators are invited to communicate with the authors for additional information.

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